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DEVELOPMENTS IN THE MANUFACTURE OF WOOD PULP

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In earliest times, the stories of great achievements were constantly repeated in the family and handed down in this way from generation to generation. These verbal records constituted history in that age. Later, about 4000 B.C., events were commemorated by means of stone obelisks, on which were rudely carved pictures for illustration, and stone tablets on which were inscribed accounts of these events. In 1500 B.C. the Chaldeans and Assyrians for this purpose used clay tablets, for which the Romans substituted waxed boards, the wax being more impressionable than the clay. Then came into great favor with the Romans the inner bark of trees or "liber," and this was the first actual step in the direction of paper. From this time on, to the time when wood pulp, mechanical and chemical, was first used, the stages of development are most interesting. We shall mention these very briefly.

About 670 B.C., in Egypt, papyrus came into use for the recording of events. This was a product of an Egyptian plant of the same name, which had long been used in the manufacture of mats and clothing. The layers of fibrous matter were removed from the stem, gummed crosswise over each other and polished. These sheets were pasted together to form the papyrus roll. The Romans adopted this writing material and later made parchment from the skins of sheep and goats, steeped in lime and finished, and vellum in much the same way.

But these are not paper in the accepted sense of the word. To the Chinese goes the credit of first making a paper from fibrous material (raw cotton at first) reduced first to pulp. From China, about 751 A.D., the Arabs learned the art of making paper from grasses, macerated flax and hemp, and about 792 A.D., they made it from linen rags with starch for sizing. This was the first pure linen rag paper. In this state of perfection, the art was adopted from Arabia by Europeans in Mediaeval times. For many years the protective policy of European paper manufacturers was so strict that the English did not establish the industry until about 1499, and then to no great extent. In 1665 the first British Patent for paper making was granted to Charles Hildeyard, and trade received great impetus from refugee Huguenots from France in 1684. Improvement, however, was slow and output small, owing to the clumsy method of converting rags into paper until the introduction of grinding machines from Germany, where improvement had been more rapid. About 1870, wood pulp, both mechanical and chemical, was introduced on a commercial scale, and the making of the lower grades of paper such as news print, received its great impetus.

Mechanical and Chemical Wood Pulp

Mechanical Wood Pulp consists of fibres which have been formed from wood by means of a grind stone and differs very slightly from the original raw wood in composition, containing most of the complex substances natural to the wood from which it is made. Chemical Wood Pulp is prepared by a chemical process in which the wood is treated with solutions which produce a form of cellulos differing very materially in composition from the original material, and lacking the resinous and non-fibrous constituents thereof. This difference between the two pulps is seen in the following table. The natural wood and the Mechanical Wood Pulp from it are so nearly alike in composition that we may place them together for comparison with the Chemical Wood Pulp from the same wood.

Table No. 1

	Wood (Spruce)	Chemical Wood Pulp
Cellulose	53.0	88.0
Resin	1.5	0.5
Aqueous Extract	2.5	0.5
Water	12.0	8.0
Lignin	30.5	2.5
Ash	0.5	0.5
	100.0	100.0

Ground Wood and Cellulose are terms synonymous with Mechanical and Chemical Wood Pulp respectively, denoting the difference in treatment to which the wood is subjected. Paper made from Mechanical Wood Pulp is used mostly for news, common printing, packing, card and box boards, while paper made from Chemical Wood Pulp which is stronger in fibre and in its power of retaining its color, is of the higher class. However, conditions of manufacture can be so modified as to produce various grades and qualities in both kinds of wood pulp.

Before considering in detail the process for the production of Mechanical and Chemical Wood Pulp, it would be well to know what woods are suitable for use in the making of wood pulp. The woods most commonly used are of the order Coniferae, or cone-bearing trees. In America, the spruce, balsam, pine and fir are generally used. In Europe, the spruce and silver fir. The relative fitness of wood for wood pulp is judged by the resistance they offer to certain strain tests put upon them. Of these strains, the breaking strain is most important as is shown by the following table by Tetmayer of Zurich.

Table No. 2

Transverse Pressure	Tension	Crushing	Shearing
Beech	Beech	Oak	Beech
Oak	Oak	Beech	Oak
Larch	Scotch Pine	Larch	Larch
Silver Fir	Larch	Silver Fir	Spruce
Spruce	Spruce	Spruce	Silver Fir
Scotch Pine	Silver Fir	Scotch Pine	Scotch Pine

From the above statement, it can be seen that the Coniferae with their massive, perennial stems and elongated cells are best converted into pulp at the lowest cost.

There are different processes in the making of both Mechanical and Chemical Wood Pulp, which we will consider in a general way.

Mechanical Wood Pulp

Three Processes: 1. Cold Grinding; 2. Hot Grinding; 3. Steam Cooked and Hot Grinding.

Grinding is the tearing away of wood when held against the surface of a rapidly revolving stone, the fibres as they leave the wood being instantly washed away by a current of water. This grinding applies to all three following processes.

Cold Grinding

This is the oldest method of making Mechanical Wood Pulp. The fibres are ground off in a large excess of water and washed from the stone as fast as produced; thus the temperature is not allowed to rise on account of friction. The quality of the product from this method is fine, even and uniform, and the production is slightly larger than by he hot ground method. This product also commands a higher price than the hot ground product. No cold ground pulp is made in Canada and very little in the United States, but is made mostly in Germany and Norway. The demand in Canada is for ground wood pulp which can be used for news print, and for this the cold ground pulp is unsuited.

Hot Grinding

In this method the wood is ground with a limited supply of water, so that it remains in contact with the stone for a longer time causing the temperature to rise from 140° to 165° F. The fibres are readily torn from the wood and produce a pulp much coarser than that which is cold ground, longer and tougher and not so uniform.

Steam Cooking and Hot Grinding

There are two ways of carrying out this process, in the main, however, they are very similar. The difference can be seen from the following:

(a) Digesting with hot water before grinding.

The wood is put in cast iron tanks, or steel tanks, copper lined, as the acids generated attack steel plate, though not cast iron. As cast iron cannot be depended upon to withstand steam pressure, the copper-lined steel tank is the best and the only one allowed in Germany. The wood, in two-foot lengths, is packed into these tank and the tanks filled with water. Then steam is turned in till a pressure of from 4 to 5 atmospheres is reached. This pressure is maintained for from three to twenty-four hours, depending on the quality of fibre desired, the highest grade being obtained from the longer cooking at the lower steam pressure.

(b) Digesting with steam before grinding.

This method is quite similar to that above described, except that the tank is not filled with water, but has steam turned directly into it after it is filled with the wood. The condensation with such products as acetic and formic acids, ethereal oils, turpentine and resin, are trapped away in modern practice to recovery tanks.

Both these methods change the wood to a brown color and the longer it is cooked the darker it becomes. This steam-cooked pulp is therefore also called "Brown Wood Pulp," and gives a product which is used for boxes and cheap wrapping. It is sometimes sold under the trade name of "Imitation Kraft." No Brown Wood Pulp is made in Canada, and very little in the United States, but a great deal in Germany and Norway, though several plants are proposed for Canada. On the North American continent, pulp making methods are much more wasteful than in Norway, Sweden and Germany, where the softer, brown-centered logs are used in the making of brown pulp. On this continent, this grade of wood, after the labor of cutting, logging and rafting to the mill, has been spent on it, is sent to the burners as its brown center prevents its use for news print and other papers requiring a clean white pulp.

This digesting of the wood is preliminary to the grinding which proceeds as in the former two kinds of Mechanical Wood Pulp, the hot and cold ground.

Chemical Wood Pulp

Two Processes: 1. Acid; 2. Alkali.

For either process the logs are cut into two-foot lengths and barked, as subsequently described in the manufacture of Mechanical Wood Pulp, and then cut into small chips.

Acid Process

There are two methods in which this process is used. The difference can be seen from the following:

(a) The Quick Cook Process.

In this process, the chips are subjected to the action of sulphur ous acid and steam at a pressure of from 80 to 100 lbs. for a period of from nine to twelve hours. The pulp produced from this process is eminently suited for the manufacture of news and wrapping paper in which strength is of primary importance and not color.

(b) The Slow Cook Process.

This method differs radically from the quick process in that the pressure is not allowed to exceed 30 to 35 lbs., while the time of boiling occupies from thirty to forty-eight hours. Moreover, the heat is applied by means of steam passed through lead coils, so that the condensed steam thus produced does not accumulate in the Digester. The pulp obtained in this case is of excellent quality and of great strength, being used only in the production of the highest grade of papers. It is frequently described as "Mitscherlich" pulp from the name of the inventor of the process.

Alkali Process

There are two chemicals used in this process, the difference can be seen from the following:

(a) The Soda Process.

The chips are digested with a solution of caustic soda, about 20 Tw., for from six to eight hours at a pressure of 100 to 150 lbs. The conditions of treatment are varied according to the nature of the wood and the requirements of the manufacturer. This process is capable of general application, being utilized for wood which cannot be used for the acid or sulphite process, such as birch, maple, and basswood.

(b) The Sulphate Process.

The chips in this process are digested with sulphate of soda, the treatment being similar to that in the soda process. The sulphate process is used on coniferous woods, which do not soften under the soda treatment as the foliage of the dicotyledens. The general manufacture of sulphate pulp is restricted, due to the evil-smelling gases formed during digesting, though the pulp produced is exceedingly strong.

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RIVER IMPROVEMENT

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The water supply of rivers primarily comes from the rain, although the total amount of rain falling over the area of a river basin in any given period is not necessarily the discharge of the river. A continuous or a very heavy rainfall produces a greater effect on the discharge of a river than the same amount of rain distributed over a greater period. Evaporation is very active in summer thereby causing a much less discharge in summer than in winter.

A knowledge of the different strata is very important. Where strata are impermeable the rain falling over the basin is rapidly discharged by numerous little rivulets into the main stream. Therefore, if the rain has been long and continuous, the river will be torrential in character—rising rapidly in rainy weather, and later falling as rapidly.

But if the rain falls on permeable strata it will soak into the ground and will take longer in reaching the main stream. Some of it may even filter into another basin. M. de Lagrene deduces that the co-efficient of discharge in relation to rainfall is .75 on impermeable strata, and only .15 on very permeable soils.

Before discussing the methods of river improvement it may be desirable to enumerate the various classes of work used. The five principal divisions of river improvement are as follows:

1. Contraction—including spurs, sills and training walls, and bank protection.
2. Excavation, including dredging.
3. Canalization—including locks and dams.
4. Lateral Canals.
5. Reservoirs.

In undertaking any river improvement for the benefit of navigation, many considerations necessarily enter into the determination of the method to be followed. For instance, the highest water level or flood level, the lowest water level or dry weather level, and the variation in the flow through successive months in the year. The kind of strata and also the slope must be known. A river, to be perfect for navigation, should be tolerably straight, with a uniform breadth and depth, and consequently of uniform flow, without a scarcity of water in summer, or too full and rapid a flow in flood times. But no river is perfect for navigation, the most of them having winding courses and a variable flow. It is the purpose of engineers to correct this as far as possible. When deposits occur in a river channel owing to low velocity, it widens out, as it is unable to scour out its own bed.

In designing the improvements of a river channel it must be borne in mind that any increase in depth and width modifies both the sectional area and hydraulic mean depth, and consequently, increases the rate of discharge, and tends to lower the low water level. In considering the improvement of any river, the whole river must be taken as a unit, not as separate parts, to be studied separately. Every river consists of deep places and shallow ones. The shoals act as submerged weirs, and if taken out will lower the water above. This has occurred on a number of rivers.

When the river is low the water is generally sufficiently deep in the pools between the submerged dams, and the current is gentle, and the navigation is free and unobstructed. Over the bars the water is low and the current rapid. The fall is concentrated at the bars and therefore navigation is difficult. But when the river rises the condition rapidly changes, for with each foot of added height the area of cross sections at the bar, or wide portion of the river, increases more rapidly than the corresponding section in the pool or narrow portion; and at a certain stage, as the water rises, the area of cross section upon the bar will be equal to that in the pool; and as it continues to rise, the area on the bar will become greater than in the pool, and the bar section will then be the one affording the greatest freedom to the flow of water, and the pool will become the narrow or constricted portion, and the velocity of the current, from having been the greatest on the bar will change and become greatest in the pool.

If the river is a silt-bearing one, and if the bottom is covered with material which can be moved by the river at the time when its velocity is greatest, then the material will be picked up during the flood, the pools will be dug out or their banks washed and the material moved forward by the water until it comes to the bar section where the current is less, and there a portion of the silt will be deposited; and the bar built up; and when the river falls the current may not be sufficient to cut a navigable way out.

River Regulation: Rivers that may be improved by this method are those of large and gentle discharge, of considerable width and small slope. A river has a definite discharge, as has been shown before, which is independent of its channel. When the channel is made narrower it tends to make up for the diminution, first, by a increase in the rate of flow occasioned by the raising of water level above the contracted portion, and eventually by scouring out its bed so as to restore its channel to its original capacity. It must not be limited to the shallow portion or the material scoured will be desposited again just below the contracted portion to produce a new shoal.

The rivers that have been improved by this means in Europe are the Rhine, below Strassburg, the Elbe, from its entrance into Germany, the Numen, through Prussia, the Rhone, below Lyons. In America, the Mississippi improvements above the mouth of the Missouri are an excellent example of this class of work, and instances of its successful application are found in the Columbia, Missouri and Tennessee Rivers, and on the French Broad and Hiawassee tributaries of the Tennessee. It is an elementary principal, that where contraction is effected, it will be necessary to protect the movable river beds. This protection is far from simple, and is often very difficult and costly. This is sometimes due to the nature of the materials constituting the banks, or to the width of the river, but more often due to a shifting and soft bottom. The regulation of the Ohio by spurs and training walls was abandoned on account of these reasons. It is doubtful whether more than a very few feet can be obtained by this method.

It may be stated in general that:

1. Only rivers, or long reaches of rivers in which natural erosion is fully developed are adapted to regulation. The navigability of unfinished rivers yet in the state of erosion can be improved only by canalization.

2. The most that can be accomplished by regulation is the desired adjustment of the slope of the low water line, and this only on reaches of uniform regimen and uniform characteristics. The depth attainable is expressed in the formula:

$$d = \left(\frac{Q}{WK \sqrt{i}} \right)^{3/2}$$

where

d—depth
Q—the measured discharge
w—normal low water width
i—adjusted slope
k—a constant, corresponding to the constant of Chezy's formula.

The preliminary step of any improvement works is always a detailed survey showing depths, nature of bottom, low water slope and velocities at various points. The main steps in contraction works are:

1. The secondary channels back of islands are usually closed, and the best location for channel selected. This is usually along one bank for various reasons; the following being the principal ones: (a) It is more easily navigated, especially at night; (b) It is cheaper to build, and more easily maintained, as the convex bank has not the tendency to refill and costs less than a dike. The first cut of dredge may also be put on bank. Spurs and training walls off both banks have been found difficult to navigate on account of the draw over them when submerged.

2. The normal profile low-water width is calculated by the usual formulas involving width, depth, and character of bed, These are checked with actual conditions in normal reaches, as mathematical formulas are never applicable to varying cases, but serve as a guide.

3. A combined system of train walls, bank protections, spurs etc., are applied so as to hold water up after the excavation is made and so designed to smooth out the inequalities in the low water slope, and distribute the fall over a longer stretch of river than before, in order to reduce the velocities.

4. The bottom is drilled and blasted. If necessary the material is dredged out and placed in the dikes.

5. After completion, the shoal is resurveyed to see if further

changes are necessary. By placing gauges above and below the dikes it may be found that dikes must be prolonged and the channel narrowed, or perhaps a dike lowered.

An example of river regulation is found on the Mississippi between the Ohio and Missouri Rivers. In its original condition the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The channels were divided by islands which formed sloughs, and secondary channels or chutes through which a great deal of the volume of water passed to the detriment of navigation. The flow is now confined to a single channel having an approximate width of 2500 feet at bankfull, the natural width being a mile or more at mean high water. New banks are built where the natural width is excessive, using for the purpose, permeable dikes that collect and hold solid matter that is carried in suspension, or rolled on the bottom of the river. The banks, both new and old, are revetted where necessary to secure permanency. This improvement, will give a minimum depth at standard low water of six feet from the mouth of the Missouri to St. Louis, and eight feet from St. Louis to the mouth of the Ohio. Dredging is used for temporary improvement during low water, pending the permanent improvement. The cost of the improvement is estimated at $16,397,000. Another example is the Mississippi River between Missouri River and St. Paul, Minn. The project is the contraction of the channel by means of wing and closing dams to such an extent as to cause scour, thereby affording a channel of sufficient width, and of a depth of 4½ feet at low water.

In the case of the Tennessee River it is found that there is no moving material in the bed of the stream; and the bed is hard and of such a character that it will not be cut out by the moderate increase of current which it may be necessary to bring about, in order to secure a sufficient depth of water on the bars. The means adopted to secure a navigable channel is brought about by spur dikes and training walls, for reducing the width of the waterway on the bar and for outlining the desired channel. These are supplemented by dredging where the depth is not sufficient, and by construction of submerged dikes or sills, where the depth is too great.

Contraction works is never carried on alone, but in conjunction with dredging. Also dredging is very seldom used as a means of original improvement, but as a means of keeping a navigable depth after contraction works have been finished. The only obstacles to navigation on the Lower Mississippi are the sand bars. The natural depths go down to four or five feet. There are nine hydraulic dredges now working which keep the depth to nine feet. The annual cost is $250,000.

Dredging is immediate in its effect as it is applied to the seat of the trouble. Dredging is not difficult to plan, and does not involve engineering difficulty, but when shoals are formed of sediment they reform very easily and have to be dredged from year to year, but when of hard material, they are quite permanent. Often the material taken out of rivers is used for making training walls and dikes in order to contract the river in the neighborhood of the cuts.

General Remarks on Dredging Machines

The bag and spoon dredge is still serviceable where the depth is slight, where the amount of work to be done is small and scattered about, and where funds do not admit of a large expenditure on a plant. The bucket dredger is well suited for the ordinary work of maintaining a river channel, where thin layers of sand and silt spreading over a considerable area have to be periodically removed. The dipper dredger possesses considerable advantage over the ordinary bucket dredger in facility of manipulation, but it can only work with its full effect when excavating a layer of four or five feet in thickness. Neither bucket nor dipper dredges are suited for working in exposed situations, as the buckets cannot adjust themselves properly to the constantly varying level of the vessel exposed to waves or swells.

The Grapple dredger and sand pump are the only machines capable of complying with this condition. In other respects they are dissimilar, for the grapple dredge is especially suited for excavating in rough and large material, while the sand pump is suitable for soft material, such as sand and silt.

The cost of dredging depends upon the cost of wages, the cost of fuel, the distance to which the material should be conveyed, the number of days in which work can be carried on, the nature of the material, and the amount of excavation within a certain space. The type of machine most advisable to be employed depends upon the material and extent of the work required to be executed.

Description of Regulation Works

Levees: Levees are banks of earth on the shore line used for protecting the country in flood times. The countries where they are mostly used are the United States, Germany, England, France, Spain and Holland. Large amounts of money are spent every year in the erection of levees in the United States. In 1908 $15,000,000 were spent on the Mississippi for levee work.

Levees follow the general line of the river if possible, but they must have hard and solid foundations. Also there must be no sharp bends, and if there must be curves these should be made as easy as possible. The height of a levee is a very important factor, for if the water goes over the top, the whole idea of the levee is lost. For this purpose a knowledge of the highest flood level is important, and the levee is generally built two to three feet higher. On a curve the levee has to be built higher than on a straight stretch, for the water has a tendency to pile up. Levees are usually built so that they may be built higher, if necessary, for often the river bed fills up from the deposit of silt and the levees therefore, have to be built higher.

The usual dimensions on the Mississippi are eight to ten feet high, with a slope of three to one with earth, and one to five for sand. The materials generally used are those near at hand. Clay makes the best material as it is impermeable and not easily washed away. Sand is not so good as it requires more material, for the slope, is less steep and is easily washed away.

Bank Protection Works

River banks very often need protecting when the river has been contracted due to the increasd velocity, which also tends to reduce the amount of silt thus making the river bed more permanent. The simplest method of protecting the bank is by putting stone on the submerged side and sodding the part above as a precaution against flood time. The more complex structures are known as revetment work.

All revetment work is divided into two parts, i.e., the part submerged and the part above water. The submerged parts acts as a foundation, and so has to be carefully laid and watched, as any deterioration is not noted. Stone is a common material used for revetment work. It may be laid down with more or less care, starting at the bottom and gradually working to the top. If the bottom is soft a trench is dug first in which to deposit the rock, which it serves as a foundation for that above.

Dry masonry consisting of field or rough stone may be placed on a bed of gravel which gives to the bottom of the stone and secures an even upper surface. Stones laid with mortar are expensive and only used where the river goes through a town or city.

Extensive works of brush, sapling and poles, etc., are used as a means of defence, both in America and in Europe. The material is cheap and as a rule may be had close at hand. Fascines consist of bundles of sticks of wood preferably willow, and should be used within a year after they are cut. They vary in length, from eight to thirteen feet and are about 1¼ feet in diameter. They are kept in position by stakes, and weighted down with stone.

Mattresses are horizontal layers of brush woven together by poles, wire, timber, etc. This method of revetment is used in Holland and is also extensively used on the Mississippi. The methods used on the Mississippi, are as follows: The bank is cleared for fifty feet and then graded to a slope of one to four, from the low water line; all tree stumps are removed, also the holes filled; at the upper end of the section a cluster of piles are driven, called an abutment and below them, along the shore every hundred feet single piles are driven to hold the mattress in place. The mattresses is floated in place and then sunk by placing stone on top. If exposed to the weather, they would soon rot, but they become protected by sand and silt, and are fairly durable and effective as a method of control of bank caving.

Dikes

Dikes are a form of structure for guiding a stream along a caving bank. The works are constructed of mattresses, timberwork, rubble stone, masonry or concrete. There are three principal subdivisions—longitudinal dikes, submerged dikes, and spur dikes. The longitudinal dikes are used for training the river in easier curves. The spur dikes run out at a small angle, thus confining the river to a smaller cross section. They also tend to silt up, thus making a new bank which is continuous from one head to another. In flood times they prevent the current from scouring out a channel at the back of the longitudinal dikes. The spur dikes are used for closing the secondary channels during the low stages of the river. Submerged dikes are placed across the pools in a river bed well below the navigable depth at low water stage. They check the ready flow through these deep hollows, thereby raising the water level of the river, over the shoals between the pools, during the low stages of the river. They also silt up and protect other works by preventing the bottom from being scoured out.

Canalization

Canalization must be resorted to whenever the discharge is too small for open river work, the slope too steep, or the depths attainable insufficient, and will usually be considered when it has been found that the simpler means are not applicable. Canalization costs more per mile than regulation works its maintenance is higher and the delay to down stream traffic is much greater, but its results are positive and immediate. It renders up-stream navigation easier than before, and affords greater safety to vessels than the other methods. It is much less limited in application than regulation works. Its range of usefulness practically commences where that of open river work ends, leaving a small debatable ground between.

In canalization, instead of increasing the depth of the river by lowering its bed, the level of the water is raised. The river is transformed by dams or weirs, into a series of level reaches connected by locks, whose chambers, being successively filled with water and emptied, serve to raise or lower a barge from one reach to the next. By this means, the requisite navigable depth is obtained with little excavation, except at the portions of the river just below the locks and at old fords; but the banks have to be raised for a certain distance above the locks and dams to prevent the river when raised from overflowing its banks. The position of the locks, and the length of the reaches, are regulated by the slope of the valley, and the fall at the lock. The lock is usually placed where a river is divided into two channels, with an island between if possible. The lock being situated in one channel, and a dam keeping up the water to the level necessary for navigation, across the other channel. If no natural division of the river occurs at a point sufficiently close to the place where a change in the water level is desirable, a site is selected where the river makes a sharp bend, a new straight channel is excavated across the bend, and the lock is constructed in this channel.

Locks: A lock consists essentially of a chamber, placed at the junction of two reaches in which water can be raised or lowered so as to be level with either reach. The lock chamber is usually closed by a pair of gates at each end; it is filled by letting in water from the upper pool through sluices in the upper gates, and side walls, and emptying it by letting it out of similar sluices at the lower end.

Locks consist of two side walls, with curved ends to facilitate the entrance and exit of boats; two pairs of gates at each end of the lock chamber shutting at the bottom against a sill. The portion of the floor upon which the gate moves is called the gate floor, and at each end of the lock there is an apron. A recess is formed in lock walls into which the gates are drawn when opened so as to be out of the way of boats when passing. It is terminated at one end by hollow quoins, and at the other by square quoins. Locks are made large enough to admit the largest class of vessels employed on the special navigation. If navigation is very large they are built to hold a number of boats. The custom once was to build a lock which was wide as well as long, but great difficulty is often found in navigating such locks. The new lock at Sault Ste. Marie is not as wide as the locks previously built, but it is built much longer so as to admit two of the largest boats, in tandem, thereby facilitating the movement of the boats out of the locks.

Water Used in Locking

Each operation in locking withdraws a lockful of water except where a descending boat finds the lock full. The least consumption of water for a single lock is when a boat ascends and another descends alternately; a single lock full is all that is necessary for the two boats. In a flight of locks, however, locking in a train of boats up and down causes less expenditure of water than alternate boats, sometimes the flight is made double so that one flight may be used for ascending and the other for descending, which considerably lessens the consumption of water. In river canalization the consumption of water is of very little importance for the water would ordinarily pass over the weir or dam.

Dams

There are two classes of dams used in canalization:

1. Fixed.
2. Movable dams which are capable of being lowered on to the bed of the river, or removed so as to present no obstruction to the waterway in flood time.

In the fixed dam the water either flows over or is regulated by stop logs. In the former case they are sometimes called over-fall weirs, and are very efficient in preserving a fixed minimum water level, but are not suitable for rapid discharge of water. The dams which may be regulated by stop logs are much more efficient for rapid discharge, and the river may be kept at any desired level.

A good example of a movable dam is on the Red River at St. Andrews Rapids. The Red River in the summer is very shallow, having little value for navigation, but in spring it has immense floods. A permanent obstruction in the river would not be practicable. The dam is of type known as the Caméré Curtain dam. It is the first dam of this type to be built in America, but one has been built on the Seine and has given perfect satisfaction in every respect. The Red River is 800 feet in width, at the site of the dam, and heavy concrete piers have been placed in the bed of the river 113 feet 8 inches centre to centre. Running between these piers and embodied with them is a heavy submerged concrete dam extending 7 feet 6 inches above extreme low water. The supporting framework of the dam is of a series of steep truss bridges resting on these piers. Each truss span supports 46 curtain frames and 5 sets of curtains. The frames are arranged in groups of twos and fours arranged firmly together. Their upper end is attached to the floor of the span by means of a hinge allowing them to swing in a vertical plane. Their lower end rests on a casting embedded in the top of the submerged dam. The curtain is unrolled against the up-stream face of the frames and is held in place by two chains fastened to the frames. The water is lowered by raising the curtains up a short distance, which makes the flow uniform and also prevents scour. After water has reached the desired level the curtains are rolled up and then the frames hoisted.

In the canalization of the Mohawk River which is part of the New York State Barge Canal, movable dams are also used. The land in the valley of the Mohawk is very fertile and the pooling of water behind permanent dams would be enormously expensive. For this reason, and on account of the immense floods, the engineers were led to build movable dams. The dams are kept closed in summer, but are opened in winter to allow the river to flow unobstructed. In times of floods the dams will act as control gates, either to let the water through gradually, or to let it flow through unobstructed.

The type of dam used on the Mohawk is known as the bridge dam with Boulé gates. It consists of ordinary looking bridge trusses upon concrete piers. The down stream chord has a number of steel frames hanging from it which swing down into the river, butting against concerte and cast iron blocks embedded in the river bed. Two sets of gates are lowered on these frames, an upper and a lower, to control high and low floods as needed. The gates are controlled by a small hoist that travels across the bridge trusses and raises and lowers the gates as desired. To let a small flow through, the two tiers of gates are separated, but in time of excessive flood the hinged frames may be swung up under the truss, clear of the water.

Reservoirs

Natural Reservoirs: Nature presents abundant examples of control of stream flow through the agency of reservoirs. A river in flood flowing into the reservoir will only cause it to rise a little, thereby keeping the out-flowing river more constant. There are very few streams whose flow is uninfluenced by such action. The most perfect example in the world is the St. Lawrence River embracing the Great Lakes, both in the magnitude and the completeness of control. Compare the flow at the outlet with the area of catchment basin in square miles. For this purpose take the Niagara River at Buffalo; the Ohio at Paducak, Kentucky; the Missouri at its mouth, and the Mississippi just above the mouth of the Missouri:

	Niagara	Ohio	Missouri	Mississippi
Watershed in square miles	265,095	205,750	530,810	171,570
Discharge in cubic feet per second	232,800	307,000	100,000	130,000

In addition to the annual fluctuation there is constantly going on a periodic change which often requires several years to complete the cycle. The mean annual level rose for 4 years, 1872-1876, and fell during the next 3 years. Thus the natural reservoirs not only tend to preserve a balance between wet and dry seasons of each, but between those cycles of wet and dry years.

These reservoirs absorb flood waters in the spring, and pay them out in the fall, thus preventing floods on one hand, and low water on the other. Navigation on the great lakes, therefore, is very stable and engineers have little trouble with low water and high water.

Artificial Reservoirs

While it is impossible to imitate nature on a scale of her own, many examples have been built on smaller scales for various reasons. The two principal reasons are (a) to prevent floods, and therefore the destruction of property, and (b) to help navigation by re-enforcing the flow when most needed.

An important factor of Reservoir action in control of floods is that even if full, it still moderates the flow of a stream below, the effect varying with the superficial area when full, and inversely with the capacity of the spillway. Every increment of depth at the outlet means a corresponding increment over the whole area. A flood passing over this will be reduced by storage due to this increment. It is then a protection against sudden floods and freshets, also giving warnings of its approach as it takes a long time to reach its maximum effect.

The largest artificial reservoir system yet in use is at the Head Waters of the Mississippi. There are numerous small lakes at the head of the Mississippi, and some of these afford splendid opportunities for artificial reservoirs. The dams are low structures, but the area over which the water is raised is enormous. The cost of storing the water per unit of volume is probably the lowest ever yet attained.

The original Mississippi project was that there should be 41 reservoirs. The object of the reservoirs already constructed at the Head Waters of the Mississippi is to collect the surplus water principally from precipitation during spring, winter, and early summer, to be systematically released so as to benefit navigation below the dams, and incidentally to mitigate the floods.

The writer thinks that navigation might be further benefited by increasing this system of improvement, and also that the present reservoir system efficiency might be increased by dredging the channels above the dams, also the channels from one lake to another. The effect of the present reservoir system on the Mississippi is to raise the water at St. Paul 12 to 14 inches.

The reservoir theory has never been applied on a large scale as an aid to navigation alone, except on two Russian rivers, the Msta and the Volga. These rivers take their source in a lake 665 feet above sea level, where the land was already flooded. Here the construction of low cheap dams was an easy task. The capacity of this system was 35,000 cubic feet, with dams only 17.5 feet high.

There are a great many reasons against the use of reservoir sites for navigation purposes. One is, that they are very expensive, as a lot of land is drowned out which is lost for agricultural purposes; also there is a high cost of maintenance; and another is the slight assistance to navigation, raising the low water level only about two feet at the most; also the doubtful efficiency when completed. It was found that on the Mississippi it would be necessary to start the discharge from the reservoir two months before it was needed at St. Louis, and experience does not justify such long forecasts, and they would also have to be based on general averages, which are very unsatisfactory.

Notwithstanding these objections there may be cases where it would be advisable to build them, but the general opinion is that storage reservoirs for navigation purposes alone will never be warranted. On the Mississippi River the dams are used for power purposes by milling and other companies.

Lateral Canals

By means of a lateral canal with one or more locks, the obstruction at any point in the river may often be obviated. Some years ago this method of improvement was widely advocated, but there are a great many objections to lateral canals. They are very expensive to build and maintain. They form pools of water where silt is deposited which has to be dredged periodically. The canals are easily blockaded and navigation slow, on account of the wash along the banks caused by high speed, which is obviated in a canalized river.

Des Moins Rapid Canal is a good example of a lateral canal. The canal is 7.6 miles long and extends along the Iowa shore from Keokuk to Nashville. The width proper is 300 feet in embankments and 250 feet in excavation, but owing to the irregularity of the shore, it stretches out in places to a width of 500 to 600 feet. The maximum depth is 5 feet. The fall at low water is 18.75 feet.

The embankment enclosing the canal varies from 60 to 90 feet in width at bottom; it has a slope of 1½ horizontal to 1 perpendicular, and is from 16 to 27 feet in height. It contains in the aggregate 884,325 cubic yards of earth, and is protected on both sides by a rip rap wall containing 111,667 cubic yards of rock. It is 10 feet wide on top with a macadam covering of 2 feet thickness. There are two lift locks and one guard lock, also used as a lift lock at high stages of the river; each having a lock chamber of 350 feet long and 80 feet wide at top, with a batter to the walls of ½ inch to the foot. The lower lock is located at Keokuk, the middle lock 2½ miles above, and the guard lock at the head of the canal 7.6 miles above the lower lock. The lift of the lower lock at low water is 11.09 feet, of the middle lock, 8 feet, and of the guard lock 9 feet, at extreme high water.

The locks are filled by means of culverts back of the lock walls, one on either side, with lateral openings into the lock. The lock is emptied by similar culverts. There are also wickets operated by hand in upper gates by which the lock may be filled; also in the lower by which it may be emptied.

In order to control the surplus water carried into the canal by numerous streams during their frequent floods, it became necessary to build sluices around the locks. While the sluices around the locks discharge the waters of two large creeks and several small ones that empty into the canal, it was found that large quantities of silt was deposited from them which had to be removed by dredging. To reduce this dredging, sluices were also built through the river bank of the canal, which could be opened when the streams were in flood and the river low, and by this means a large amount of the silt was discharged into the river.

A large item in the cost of maintenance is the periodical dredging required to remove the deposits formed in the sand. While some sediment is deposited from the river water, the principal source of trouble is material washed in from the neighboring hills during storms. There was 2,181,743 cubit yards removed from the canal from 1878 to June 30, 1906, an amount in excess of the excavation during construction.

As a summary of this discussion, the following conclusions are briefly stated:

1. Regulation in some suitable combination with channel excavation should always be first studied as a method of river improvement and adopted in all cases where economically applicable. It will often be used wherever the funds available are small, the needed increase of depth not great, the river flow comparatively large, the banks low and the width of the river considerable, velocities low and regimen more or less fixed.
2. Canalization with movable or fixed dams will be adopted wherever regulation with channel excavation is insufficient or unsuitable. It will usually be applied where the slope is steep, the discharge small, and the depths obtainable by regulation insufficient.
3. Lateral canals should never be selected for use unless imperatively demanded by the local conditions.
4. Reservoirs are too uncertain, too unsafe and too expensive for exclusive use in river improvement. They will seldom be relied on, except in special cases in connection with other enterprises where their use for industrial purposes warrants the cost and the water flow can be sufficiently controlled to operate benefically on the channels.

W. B. Buchanan, B.A., Sc., '13, has been employed as assistant engineer on the erection of the National Brick Company's power plant at Cooksville, Ont., during the summer.

G. M. Carrie, B.A., Sc., '13, is resident engineer on waterworks rs at Neepawa, Man., for Messrs. Chipman & Power.

THE WOOD PRESERVING INDUSTRY

In the early days of civilization in Canada, no thought of such an industry as timber preservation ever entered the minds of her people. In fact, the one thought in the minds of those most interested in the development of the country was of a means for the destruction of timber. We can not but admit that their course was the proper one at that time, so that the land might be put to some more remunerative use. The general tendency has been in accordance with the old established law of "Supply and Demand," but due to lack of foresight we have undoubtedly overstepped the line of equilibrium. The commercial and industrial activities have so expanded that we now feel the necessity of placing some restraint upon our heretofore indifferent and wasteful treatment of our timber resources.

Probably the most destructive agent with which we have to contend is the forest fire and any money which the governments appropriate toward the prevention of such conflagrations is certainly saving many times its value in timber. There is, however, a grand opportunity for them to follow the worthy example set by some of the European countries, especially Norway, in reclaiming large areas of untillable land by reforestation.

Now that those timbers which best resist decay and insects are becoming less plentiful and consequently more expensive, the consumer is turning his attention to the more easily available timbers, since the results of many experiments have shown that by proper treatment, they can be made to supply his need equally well at a lower cost. Among the woods that have been largely treated so far, are the yellow pines—particularly the Loblolly pine, the Douglas fir, the Western pine, and the lodgepole pine. Lately, gum and beech timbers have been treated to considerable extent in the United States for cross-ties. In Europe, the beech has been one of the principal cross-tie woods for many years, its value, when given proper treatment, having been long ago recognized. European roads often secure as much as twenty-five years' service from properly treated beech cross-ties, whereas, if untreated, they would scarcely last long enough to warrant their use at all. Until recently the oaks and southern pines furnished the majority of ties bought by railway companies in America, but now that the value of timber treatment is being fully realized, these more expensive and rarer timbers are fast being replaced by the other woods.

Wood is an organic body with an outer layer composed of sapwood and water, containing cells in which there is a large amount of organic substances, and with an inner structure called heartwood, usually distinguished from the sapwood by its dark red color. Heartwood is filled with gums and resins and contains less water than sapwood; and, therefore, is more durable.

The organic substance is subject to being destroyed by either bacteria, insects, fungi, or spores, which upon entering the cells destroy them by feeding on the cellulose. Decay can be prevented by excluding heat, air, or moisture, but since it is not often practicable to do this, the cell walls or fibres must be impregnated with an antiseptic that will prevent the introduction of bacteria, insects, fungi, or spores into the wood. In some cases the preservative may merely act as a mechanical hindrance to insects and worms, but where a heavy treatment is given some preservatives are believed to exclude air and moisture, thus rendering it impossible for fungi to develop.

Modern timber preserving is accomplished largely by the use of antiseptics such as are found in coal tar, and some metallic salts. The creosoting process is very common, but in many buildings the use of the creosoted timber is not permissable owing to the odor which it emits and to the effect of the creosote on the appearance of the wood. Some salts, such as mercuric chloride, copper sulphate and certain arsenic salts are fairly good preservatives but are objectionable, especially in dwellings, owing to their poisonous nature. Mineral acids such as sulphuric acid and hydrochloric acid will destroy the fungi, but are liable to injure the wood. Petroleum has been recommended, but it increases the inflammability of the wood and causes it to emit a disagreeable odor for a long time. A solution of salicylic acid, while being probably as effective as creosote and leaving the timber odorless, is much more expensive than the other treatments.

The primary stage in any timber preserving process consists of seasoning the wood, either by piling in the open air or by steaming in closed retorts to expel the moisture and sap. Care should be exercised, in piling the timber for seasoning, that provision is made for a free circulation of air about the timbers. In some cases timbers such as beech, have been known to deteriorate considerably through decay, before treatment, owing to improper piling in the yards. The timber should be stripped of the bark, for in many cases it will act as a preventative to the evaporation of sap and moisture. The steaming process not only facilitates the removal of the contents of the wood cells, but also, by raising the temperature of the wood through 100° Centigrade, sterilizes it and prevents absolute deterioration by rot so long as the outside cells are filled with preservative. Great care should be exercised in steaming the timber, or otherwise the wood may be materially injured. The cells may be broken by the expansion of steam formed from the sap and water in the cells, or they may be charred by too much heat. It is considered a good practice to test timber which has been steamed at over 35 pounds pressure.

The best treatment for timber depends largely upon the time when it is cut. It is only recently that the consumer has begun to realize the importance of the time of cutting, with relation to the life of timber. Some railroads in the United States specify the months in which the timber is to be cut. If cut in winter months when the sap is out of the tree, and placed where it can get the spring rains, the pores of the wood, being open, will take water, get water soaked and rot quickly. On the other hand, if cut when the sap is up and placed where the hot sun will shine upon it, it will also rot very quickly,—more quickly than the winter cut water soaked timber; but if it is piled in open cribs and seasoned it will last very much longer. Winter cuts will take some water, even after six months' seasoning. The timber cut in the spring when the sap is up, and properly stacked, after seasoning six months, will shrink considerably in cross section, thus closing up the pores of the wood, and will not take water even under unfavorable conditions. The sap, especially in all oak, is a tannic acid, and when drying up, closes the pores and acts as a preservative, thus rendering the wood much more durable then if it were winter-cut. Also, if Southern or Norway pine is cut when full of sap, the sap will commence to crystallize and turn to rosin in about a month, thus rendering the life of the timber at least three times as long as if winter cut, when used as cross-ties or piling.

The methods of treating timber with preservatives may be divided into two groups—

(1) The pressure process,
(2) The non-pressure process.

Each of these groups may be subdivided into two divisions—

(a) The full cell process, in which the cells are left filled with the preservative (except what is lost by drippage).
(b) The empty cell process, in which the preservative after being absorbed by the timber, is withdrawn by means of a vacuum created in the retort, leaving only the cell walls coated with the preservative.

The pressure process gives a heavier and more uniform penetration and impregnation than the non-pressure process, and is, therefore, more desirable for large structural timbers. The non-pressure process is much cheaper, and so is largely used for treatment of cross ties and other timbers where a heavy treatment is not necessary, and where the mechanical life of the timber is the determining factor after treatment. The full cell process leaves the timber more water proof and air-proof than the empty cell process, but the latter is largely used, on account of the saving of preservative, especially if there is no danger of leaching, since the cell walls are impregnated with a coating of the preservative.

Probably no branch of work has benefited more from the study and practice of timber-treating than has the building of submarine structures. Deterioration of submarine structures may be divided into two divisions—

(1) Deterioration at the surface
(2) Deterioration beneath the surface.

Submarine timbers are attacked not only by rot, but also by shipworms, which bore into the wood and destroy the cell walls.

On the Lower Mississippi between St. Paul and St. Louis, untreated yellow pine is used but very little in barges since it has been found that an untreated yellow pine barge, containing a minimum proportion of sappy timber, is past economical repairs at the end of ten years. With but few exceptions, the necessity for repairs to an untreated barge is due to decay and not to mechanical abrasions. It is not uncommon to find evidence of decay on untreated fir barges at the end of three years' service. Pressure treated yellow pine barges have been used on the lower river for fourteen years and are still quite sound and good for at least eight or ten years more. A table of costs in "The Proceedings of the American Wood Preservers' Association, 1912" shows creosoted fir to be by far the most economical material for barge construction.

It is essential for the successful treatment of piling, that a preservative which is insoluble in water be used and in large quantities. Where the piles are to be placed in salt water, a preservative of strong antiseptic qualities is generally considered to be the only kind which will retard the detrimental work of the shipworms. Since a deep and thorough penetration is essential, the woods with relatively high absorbing qualities should be chosen. The pines of the Gulf of Mexico and the Atlantic coast give very good results when properly treated.

Some piles forming a part of the Sandy Point Dike across Fore Hale Bar, near New Haven, Conn., were treated by the full cell process of creosoting. They were driven from 1883 to 1886, and since then have been subjected to very severe conditions. They were driven in salt water and are alternately covered at every high tide and exposed at every low tide. After twenty years' service many of the piles were just as good as when put in, and in the few cases where deterioration had set in, it was due to rot, which apparently began at the top and worked down through the middle leaving a shell. The shipworms apparently had done no damage except where the timber had first begun to deteriorate by rot. If the top had been thoroughly protected it is not likely that any appreciable deterioration would have taken place.

Telephone, telegraph and electric power companies consume millions of poles annually and the number is rapidly increasing. The greater number of them are cedar and chestnut, cedar composing about three-fifths of the total number. Since the region of supply is limited and transportation expensive, other species, such as lodge-pole pine, and engelmann spruce, are now being treated. According to Bulletin No. 13, issued by the Forestry Branch of the Department of the Interior, Ottawa, an annual saving of $6.40 per mile of line may be realized by the proper creosoting treatment of cedar poles.

The preservative treatment of poles has many features to recomment it in Canada. The supply of cedar is comparatively small, and, since the growth of cedar is very slow, it requiring 175 to 200 years to produce a 30 foot pole, it is not sufficient to supply the increasing demand. The use of preservatives will not only save money for the consumer but also lessen the drain on the forest, by treating the cheaper woods, such as spruce and pine, which, when properly treated, give just as satisfactory service as cedar and are more plentiful.

Fire killed lodge-pole pine and engelmann spruce, which are to be found in fairly large quantities on the Eastern slope of the Rocky mountains, in a sound, strong and well-seasoned condition, should make even better poles than cedar, if properly treated. They have been treated in the United States with very satisfactory results. They stand in good pole sizes and are more convenient for the extensive prairie market than poles now brought from the East. A small percentage of this timber is at present used for mining timbers.

In March, 1908, the San Joaquin Light & Power Co., of Fresno, Cal., set a 30 mile line with poles of western yellow pine. The poles were cut in the sierras, above Fresno, at an elevation of about 4,000 feet and were thoroughly seasoned before treatment. About 50 per cent. of the poles were given an open-tank creosote treatment. Some of the others were given a similar treatment with zinc chloride and some with crude oil. A few were given a brush treatment with carbolineum and crude oil. In order to get a comparative life of the wood, treated and untreated, stubs of untreated timber were set along the line about one mile apart.

After 27 months the untreated stubs were completely rotten. Nearly one-third of the brush-treated poles showed decay. Those treated with zince chloride showed about the same deterioration. Forty-five per cent of the poles treated with crude oil showed signs of decay while all those treated with creosote in the open tank were perfectly sound.

Suppose that certain timbers put to a certain use will last five years without treatment. Disregarding interest charges, it is evident that in order to effect a saving, the cost of treatment must be less than the additional cost of new timbers five years later plus the cost of setting. In treating on a large scale, the additional cost in most cases will not exceed the present purchase price of timbers, and so the saving secured will be at least the cost of re-setting the timbers plus the advance in the price of the timber in five years; that is, considering the life of timber to be increased five years by treatment, which time in many cases would be three or four times as much depending upon the treatment and the use to which it is to be put. The replacement of timber often necessitates the shutting down of the plant, as is the case in putting in a mine shaft, thus causing considerable financial loss to the company.

One can not say that any one of the various methods of treatment is absolutely the best, each process being peculiarly adapted to certain governing conditions such as the cost of treatment, the degree of impregnation desired, the nature of the wood to be treated and the use to which it is to be put. The question of treatment, therefore, resolves itself into a matter of investment, and to secure the best results, the wood must be treated so that the chemical life will be equal to the mechanical life. Hence, the mechanical arrangements are often as important as the chemical treatment. The strain and shock should be distributed throughout the whole timber so far as possible, so that there will not be premature failure in small portions, due to their bearing too great a share of the work.

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EDITORIAL

CLASS 1T7

To class '17 we extend a hand of welcome. You are entering upon a new field to make final preparations for your lifework. You have done well in deciding to make the engineering profession your choice, for it offers a field, strewn with opportunities for the young men of our country. We would remind you, however, that studying for examinations alone will never make a successful engineer; although a certain amount of application to academic studies is absolutely necessary. The associations which you form while at college have much to do in determining what your success in the future shall be. Become acquainted with, and mingle with, so far as possible, men who are actively engaged in the engineering profession, so that you may become acquainted with the field upon which you are entering. It is also essential that you devote a portion of your time to the perusal of engineering literature such as is to be found in the engineering journals of to-day. In this way your conception of the work and your knowledge of existing governing circumstances will become enlarged so that you may upon graduation enter the field of your profession without experiencing the handicap of unfamiliarity which too many have to overcome.

Nor is University life made up of studies alone. An active and healthy brain depends upon an active and strong physique. The athletic activities of University life afford abundance of opportunity to those who wish to take part in them. We look to you to supply new material to our School teams so that our faculty may continue to hold the enviable position which it now holds in athletic circles. Again, there is the social phase of University life. So far as your other duties will permit you, it is well to take an interest in University affairs such as class dinners, the annual School dinner, the School dance, etc. They will afford many hours of pleasant retrospect after graduation.

SCHOOLMAN ON TORONTO HYDRO COMMISSION

The appointment of Mr. R. G. Black, '95, as a member of the Toronto Hydro-Electric Commission, reflects honor upon the "Old School" and credit upon the Ontario Hydro Commissioners who made the appointment. Mr. Black has the heartiest congratulations and best wishes of every School man in his appointment to this new office of responsibility, where he succeeds Mr. H. L. Drayton, K.C., now chief commissioner of the Dominion Railway Commission.

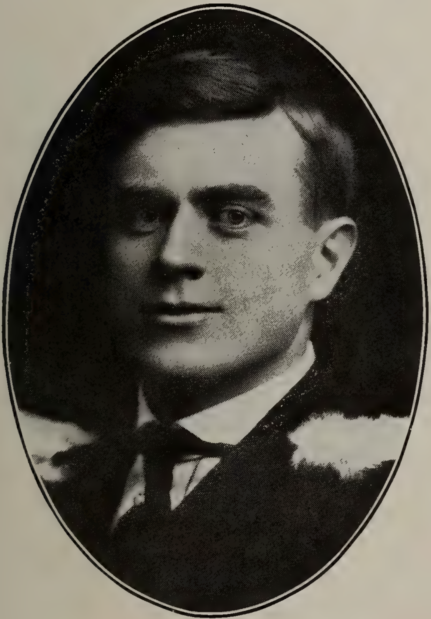
The Provincial Commission, no doubt, wanted a practical man as their representative on the local commission, who was familiar with existing conditions in Toronto, and Mr. Black's qualifications justify their judgment in every detail, the proof of which is evident in the general approval with which the appointment is received.

On leaving the "School" Mr. Black entered the service of the Westinghouse Co. in Pittsburg, and later was employed by the city of Pittsburg. From here he went to Montreal, where he was given charge of the water-power development plant at Chambly by the Royal Electric Company, which did the city's lighting and was later known as the Montreal Light & Power Co. About 1900 he came to Toronto and became general superintendent and chief electrical engineer for the Toronto Electric Light Company, with which company he was connected for a period of about ten years. Mr. Black spent eight months in England, Scotland, Germany, Sweden and Austria, where he added considerably to his wealth of engineering knowledge. Upon the retirement of Mr. Sweaney as acting manager of the Toronto Hydro, Mr. Black assumed the duties very ably until the arrival of the new general manager, Mr. Couzens.

His wide practical experience renders him specially fitted to undertake his new duties and we will always be glad to hear of his continued success.

OUR PREDECESSOR

If there is one man to whom "School" men should take off their hats it is Hyndman Irwin, '09, who since graduation has so ably and unselfishly assumed the duties of editor of "Applied Science," general secretary of the Engineering Society and secretary of the University of Toronto Engineering Alumni Association. During that time he applied himself so diligently to the interests of the Society that under his leadership it has grown to be a much more useful medium than ever before. Under his editorship "Applied Science" was increased to twelve issues per year, a venture which is amply justified in view of its increased circulation and its increased value as a medium to keep the graduates in touch with one another and to bind together the graduate and undergraduate bodies in a stronger unit which will ultimately be of immense value to "School" men. It was largely due to his efforts as secretary of the Engineering Alumni Association that it became the thoroughly organized and active body which it now is.



Hyndman Irwin

When he severed his immediate relations with the Society to assume his new duties as editor of the "Canadian Engineer" we lost the services of one who had done more than any other individual for the Engineering Society and for the graduates, during his three years of office. We wish him every success in his new work and feel that in him the red-back engineering journal has a man who will assure success.

Mr. Irwin entered the school with year '09 and took a course in mechanical engineering. To be consistent he graduated with honors, after which he was employed by W. D. Black and his executive of the Engineering Society. As manager of the supply department he won the respect of the student body, being always firm but obliging in even the smallest details. His excellent management of this department effected a saving of many dollars to the undergraduates and also increased its field of usefulness and convenience by introducing new additions to the stock.

He has shown apt ability at journalism and his knowledge of engineering work is far above the average. There is scarcely a school graduate in whose mind Mr. Irwin is not a familiar habitant and he is the recipient of the well deserved appreciation of all who are acquainted with the unselfish work which he has accomplished in our interests.

THE SMOKE NUISANCE

The general tendency is to look upon the smoke nuisance as a necessary evil. It is true that considerable complaint has been laid against the steam locomotive since it was first used, and although some success has been experienced in attempts to abate the evil of locomotive smoke, yet the many difficulties which the problem presents, will still necessitate much experimenting before an economical, reliable and effective means can be arrived at. Probably not more than one-third of this existing annoyance is due to the locomotive, even in localities where there are comparatively few industries, so that much might be accomplished if more energy were directed toward other sources of smoke which present less difficulty, in particular, the stationary boiler.

A successful abatement of smooke would not only result in the saving of millions of dollars to the citizens of manufacturing centres, but would also remove a serious menace to the health of those residing within the smoke area. We always raise strong objections to suspended matter in drinking water, but fail to realize that amount of suspended matter in air which is inhaled every day.

According to a bulletin issued a short time ago by the Smoke Research Department of the University of Pittsburg the financial loss to the city of Pittsburg as a result of the smoke nuisance is approximately $10,000,000 per year. Other cities suffer in like manner, and such figures are quite convincing that a successful means of curtailing the smoke evil will be welcomed by manufacturer and consumer alike.

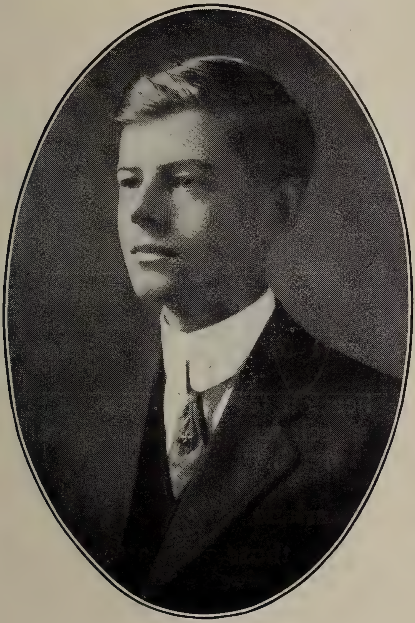
In the first place smoke is evidence of imperfect combustion and so represents a loss to the smoke maker. If we could form an estimate of the extra expense due to smoke represented in extra laundry bills, dry cleaning bills, house-cleaning work, renewal of wallpaper, curtains, etc., corrosion of sheet metal, exterior painting, etc., we would undoubtedly be astonished at the magnitude of this evil which we have to combat. Furthermore, the deteriorating influence of smoke in wholesale and retail stores, in office buildings, hotels, hospitals and public buildings adds greatly to the destructive influence of this existing evil.

It is to be hoped that civic corporations will do their share in combating this annoyance which not only renders a city unfit for several desirable industries, but also makes it an undesirable place in which to choose a home.

OBITUARY

Donald A. McCaw

It is with a feeling of deep sorrow that we record the very sad death of one of our number, Mr. Donald Arthur McCaw, of Class '14, son of Mr. and Mrs. John McCaw, Hellems Ave., Welland, Ont. On Wednesday morning, Sept. 10th, he suffered a sudden attack of appendicitis and underwent an operation on Wednesday afternoon, but from the first his case was critical and he passed away on the following Saturday night at the early age of 21 years.



DONALD A. McCAW

He received his early education in Welland, where he was born. He entered the Faculty of Applied Science of the University of Toronto with Class '14, in the department of civil engineering. During his three years at the "School" Don had won the esteem of a very large number of friends at the University and the sad news of his sudden demise comes as a shock to all who knew him. During his course he not only attained a record heretofore unequalled, always holding the highest standing in his class at examinations, but also took an active part in University life. His classmates showed their appreciation of him by electing him vice-president of their executive last year.

During his course at the University of Toronto the deceased displayed such true manliness and so genial a disposition as to create in the hearts of his fellow students a friendship which time will not easily efface. These sterling qualities accompanied by his exceptional ability in engineering work afforded him the brightest possible prospects. In his demise the engineering profession has lost one of her very brightest and ablest candidates and his fellow students have lost a worthy, upright and true-hearted companion.

To his father and mother and brothers we extend our most heartfelt sympathy in their bereavement.

Donald Matheson

Donald Matheson, eldest son of Rev. J. A. Matheson, of Priceville, Ont., died at the Victoria Memorial Hospital, Toronto, on Sunday morning, September 21st, after suffering untold agony. He had been with a Canadian Pacific Railway survey party in Northern Ontario during the summer and was severely bitten by black flies a few weeks ago. The bites became infected and blood poisoning eventually set in.

As the nearest doctor was ninety miles distant the young man dressed the sores himself for some time, but when excruciating pain set in medical attention was summoned on the advice of the chief of the survey party. At first his case was diagnosed as muscular rheumatism, but after his arrival in the city an examination disclosed the fact that he was suffering from blood poisoning. He was taken to the hospital, but soon after, septic pneumonia set in and delirium seized his brain. He died on Sunday morning without regaining any degree of consciousness. On Sunday afternoon a short service was held at Humphrey's undertaking parlors, conducted by Rev. T. E. Bartley, assisted by President Falconer and several city clergymen. The body was sent to Priceville where the funeral was held on Monday.

Mr. Matheson had made application for registration at the University in the faculty of applied science and received notice of his acceptance shortly before his death.

Alexander Macfarlane

It is with surprise and regret that those who attended the special course of lectures last February given by Dr. Macfarlane will hear of his death which occurred on August 28th.

Dr. Macfarlane was born in Blairgowrie, Scotland, in 1851, and obtained the degrees of D. Sc. in mathematical and physical science at the University of Edinburgh in 1878 and L.L.D. at the University of Michigan in 1887. He has held positions on the staff of Edinburgh University, of the University of Texas and of Lehigh University. He was elected Fellow of the Royal Society of Edinburgh and member of the Washington Academy of Sciences. In 1899 he became General Secretary of the International Society for Promoting Space Analysis, and was President of the Section of Mathematics and Astronomy of the American Association for the Advancement of Science. He was the author of the "Algebra of Logic," "Physical Arithmetic," and "Elementary Mathematical Tables," as well as many papers on "Space Analysis," and kindred subjects.

Dr. Macfarlane belonged to the intuitive class of mathematicians and his greatest interest was the problem of the most natural extension of elementary analysis to space analysis. It was with the idea of encouraging this study among students of engineering that he gave the course of lectures last winter. He has occupied a very prominent position in this study and at the time of his death was President of the International Society for promoting this study, which includes among its members mathematicians from nearly every civilized country, including for example Japan and Argentina.

DIRECTORY OF THE ALUMNI

This department began in November, 1912, and the entire list of graduates will be reviewed before the end of the year.

A number of corrections have been received bearing upon the part of the directory which has already been published, and our list of addresses is thus becoming more authoritative. If those whose names will appear during the next several months will assure themselves that our record of their location and employment is correct before publication, it will be improved still more, as there are some addresses upon our files that are long standing and hardly to be depended upon.

K (*Continued*)

Kirkwood, M., '11, is with the American Telephone & Telegraph Co., New York city, in the engineering department.

Kirwan, G. L., '10, is in the topographical surveys branch, Department of the Interior, Ottawa.

Klingner, L. W., '07, is resident engineer for the Crow Lake branch of the Canada, Lake Ontario & Western Ry.

Klotz, H. N., '09, is chemist for the Gutta Percha Rubber Co., Toronto.

Knight, R. H., '02, is a member of the firm of Driscoll & Knight, engineers and surveyors, at Edmonton, Alta.

Knight, S., '10, is in the employ of Driscoll & Knight, Edmonton Alta.

Kormann, J. S., '98, is general manager of Kormann Brewing Co., Limited, Toronto.

Kribs, G., '05, is chief engineer for the Texas Power & Light Co., of Dallas, Tex.

L

Laidlaw, J. T., '93, has a practice as consulting mining engineer at Cranbrook, B.C.

Laidlaw, A., '01, is engineer and sales agent for the Trussed Concrete Steel Co., Houston, Texas.

Laing, W. F., '96, (deceased).

Laing, A. T., '92, is secretary of the faculty of applied science and engineering, University of Toronto.

Laing, P. A., '05, is divisional engineer for the Transcontinental Ry. at Cochrane.

Laird, R., '86, is a member of the firm of Laird & Routley, engineers and surveyors, Haileybury, Ont.

Lamb, F. C., '07, is with Phillips, Stewart & Lee, engineers, at Saskatoon, Sask.

Lamont, A. W., '09, is assistant engineer with the Canadian Westinghouse Co., 158 Portage Ave., Winnipeg, Can.

Lane, A., '91, (deceased).

Lang, A. G., '03, is underground superintendent for the Toronto Hydro-Electric system, Toronto, Ont.

Lang, J. L., '06, is a member of the firm of Lang & Keys, engineers and surveyors, Sault Ste. Marie, Ont.

Langley, C. E., '92, is a member of the firm of Langley & Howland, architects, Continental Life Building, Toronto, Ont.

Langmuir, F. L., '02, is chemist for the M. Langmuir Manufacturing Co., Toronto, Ont.

Langmuir, C. B., '09, is manager of the electrical department for the Factory Products, Limited, Toronto, Ont.

Lanning, J., '11, is with the "Ben-my-chree" Mines in northern British Columbia, in complete charge of the company's administrative work there.

Larkworthy, W. J., '04 (deceased).

Laschinger, E. J., '92, is mechanical engineer with H. Eckstein & Co., Johannesburg, Transvaal, S.A.

Lash, F. L., '93, is manager of the Electrical Supply Co., Board of Trade Building, Bandoeng, Java.

Lash, N. M., '94, is assistant electrical engineer with the Bell Telephone Co., Montreal, P.Q.

Latham, R., '99, is chief engineer, T. H. & B. Railway. His address is 146 Aberdeen Ave., Hamilton.

Latornell, A. J., '03, is city engineer for Edmonton, Alta.

Latornell, A., '05, is assistant engineer in the sewer department, City Hall, Toronto.

Lavrock, J. E., '98, is draftsman for Herman & Burwell, engineers, Vancouver, B.C.

Lawler, E. R., '10, is engaged as inspector with the Toronto Hydro Electric system, Toronto, Ont.

Lawson, W. L., '92, is manager of the Great Western Sugar Co., Sterling Col.

Lawrie, R. R., '96 (deceased).

Leaver, C. B., '10, has 459 Bloor St., Toronto, as his last address with us.

Lee, W. A., '92 (deceased).

Lee, R. G., '10, is power engineer with the Toronto Hydro Electric system.

Leighton, J. W., '05, is president of the Leighton-Jackes Mfg. Co., Toronto, Ont.

Leitch, J. N., '10 (deceased).

Lennox, A. E., '09, is publicity engineer for the National Electric Lamp Association, Cleveland, Ohio.

Lepan, A. D., '07, is assistant superintendent of Buildings and Grounds, University of Toronto.

Leslie, J. N. M., '08, is with the Canadian Westinghouse Co., as sales engineer.

Lewis, F. C., '08, is with the American Bridge Co., at Chicago, Ill.

Leibermann, M., '11, is with the Saskatchewan Government on survey work. The last address we have on record is Tuxford, Sask.

Lillie, G. L., '11,—No record.

Lindsay, J. H., '07, has Hornby, Ont., as his permanent address.

Linton, A. P., '06, is with the department of public works, at Regina, Sask.

Lloyd, N. C. A., '09, has Solina, Ont., as his permanent address.

Long, A. L., '11, is chemist for Park, Blackwell & Co., Toronto, Ont.

Longstaff, J. C., '10—we do not know where he is employed.

Lott, A. E., '87, has a practice as consulting railway engineer, 441 Bradbury Building, Los Angeles, Cal.

Loucks, R. W., '09, is a member of the firm of Brown & Loucks, engineers and contractors, Saskatoon, Sask.

Loudon, T. R., '05, is lecturer in metallurgy, University of Toronto. He is also a member of the firm of James Loudon & Hertzberg, engineers, Toronto.

Lowrie, A. W. P., '11.

Ludgate, B. A., '85, is assistant engineer for the P. & L. E. Railway, Pittsburg, Pa.

Lumbers, W. C., '01, is a member of the engineering staff, for C. P. Railway, at Calgary, Alta.

Lynar, H. R., '08, is a member of the engineering staff of the Ontario Power Co., Niagara Falls, Ont.

MAC

Macallum, A. F., '93, is city engineer at Hamilton, Ont.

MacAndrews, W. M., '11, is with the Allis-Chalmers-Bullock Co., Dominion Trust Building, Vancouver, B.C., as assistant sales manager.

Macauley, R. V., '11, is demonstrator in electric engineering at the University of Toronto.

MacColl, E. B., '11, is assistant surveyor in the Department of Naval Service, Ottawa. Address mail to Hydrographic Survey, Ottawa.

MacBain, J. T., '11, 124 Fourth St., New York, N.Y.

MacBeth, C., '96 (deceased).

MacBeth, R. E. A., '11, is with the Roadways Department, City Hall, Toronto.

MacDonald, A. D., '10—no record.

MacDonald, J. B., '10, is district manager for the Canadian Inspection & Testing Laboratories at Winnipeg.

MacDonald, J. A., '10, is a fellow in surveying at University of Toronto.

MacDonald, G. A., '10, has Fernie, B.C., for his address.

MacDonald, F. M., '11, is a contractor with the Randolph MacDonald Co. Limited, Toronto. His address is 3 Rusholme Rd., Toronto.

MacDougall, A. C., '01, is assistant superintendent of the Aluminum Co. of America, Massena, N.Y.

MacFarlane, E. D., '09, is assistant engineer with the Houston Electric Railway Co., Houston, Tex.

MacGregor, A. E., '10, is with Chipman & Power at Simcoe, Ont.

MacKay, A. G., '07, is a member of the engineering staff of the Hudson & Manhattan Railway Co., His address is 30 Church St., New York.

MacKay, J. T., '02, is an undergraduate in the faculty of medicine at the University of Toronto.

MacKay, E. G., '10—no record.

Mackenzie, K. A., '06, is a member of the firm of K. A. Mackenzie & Co., Ft. George, B.C.

MacKenzie, W. S., '11, is with the Canadian Linderman Co., Limited, Woodstock, Ont.

MacKinnon, J. G., '09, is resident engineer for the C. N. Railway at Fitzhugh, Alta. His permanent address is care of Rev. N. D. Mackinnon, Caledonia, Ont.

Mackinnon, W., '06, is engineer in the erection department; with the

McClintic Marshall Construction Co., Wilkinsburg, Pa.

MacIntosh, D., '98, is chief superintendent with F. M. Andrews & Co., Metropolitan Tower, New York, N.Y.

Maclachlan, W., '06, is local manager of the Trenton Electric & Water Co., at Belleville, Ont.

MacLachlan, W. A., '09.—no record.

MacLaurin, J. G., '11, is assistant engineer in the Construction department, for the E. B. Eddy Co., Hull, Que.

MacLean, B. A., '09, is engaged in switchboard and power plant designing with the Canadian General Electric Co., at Peterboro, Ont. His permanent address is Orillia, Ont.

MacLennon, G. G., '10, is engaged as engineer for The Foundation Co., Limited, of Montreal and Vancouver, on the foundations of the new customs examining warehouse at Ottawa.

MacLeod, G., '07,—no record.

MacLeod, D. D., '10, is with the Department of Interior, at Calgary, Alta.

MacMillan, G., '01, is with the Topographical Surveys Branch of the Department of Interior at Moose Jaw, Sask.

MacMurchy, J. A., '96, is chief draftsman in the turbine department of the Westinghouse Machine Co.

MacMurchy, H. G., '10, is employed as generating and sub-station designer for the Toronto Power Co.

MacPherson, N. W., '09. No record.

MacTavish, H. J., '10, is on the engineering staff of the City Hall, Toronto, Ont.

Mc

McAllister, J. E., '91, is manager of the British Columbia Copper Co Limited, Greenwood, B.C.

McAllister, A. L., '93, has a practice as consulting engineer. His office address is 612 Continental Life Building, Toronto.

McAlpine, D. D., '09, is engineer for the Riordan Paper & Pulp Co., Hawkesbury, Ont.

McAndrews, J. B., '11, has 70 Church St., St. Catharines, for his address.

McAree, J., '82—deceased.

McArthur, R. E., '00, is in the C.P.R. construction department, Montreal, Que.

McArthur, A. S., '09,—address not known.

McAuslan, H. J., '03, is on the staff of the T..& N. O. Railway at North Bay, Ont.

McBride, A. H., '02—address not known.

McBride, T. C., '10, is with the Western Construction Co., at Regina, Sask.

McCollum, C. R., '09, is with the Toronto Hydro Electric system. His address is 77 Roper Ave., Toronto.

McConnell, A. W., '06, is lecturer in architectural design at the University of Toronto, Toronto, Ont.

McCordick, A. S., '09, is assistant to the city engineer, Sault Ste. Marie, Ont.

McCuaig, O. B., '04, is superintendent of the Entiat Light & Power Co., Wenatchee, Wash.

McCuaig, P. J., '09, is with the Westinghouse Machine Co., Pittsburg, Pa.

McCulloch, A. L., '87, has a practice as engineer and surveyor at Nelson, B.C.

McCurdy, J. A. D., '07, his last address with us is Hammondsport. N.Y., where he was with Graham Bell, Esq.

McDougall, J., '84 (deceased).

McDougall, S. G., '10—his home address is 287 McLaren St., Ottawa, Can.

McDowall, R., '88, is city engineer for Owen Sound, Ont.

McEachren, J. A., '11—no record.

McElhanney, T. A., '10—no record.

McElroy, R. W., '11—no record.

McEntee, B., '92, has a stationery store at 38 Queen St. E., Toronto.

McEwen, G. G., '04, is with T. H. Dunn, O.L.S., Winchester, Ont.

McEwen, H. J., '11—no record.

McFarlane, G. W., '88, is on the city engineer's staff, Toronto, Ont.

McFarlane, T. J., '93, is chemist for the Antikokan Iron Co., Port Arthur, Ont.

McFarlane, J. A., '03, is chief draftsman with the Hamilton Bridge Works, Hamilton, Ont.

McFarlane, W. G., '04, is engineer and surveyor in the Peace River District.

McFarlane, J. B., '07, is a Dominion land surveyor. His address is 60 Lonsdale Rd., Toronto, Ont.

McGarry, P. G., '10, has Merriton, Ont., for his home address.

McGeorge, W. G., '08, has a practice as consulting engineer at Chatham, Ont.

McGhie, W. G., '11—no record.

McGibbon, C. P., '04, is with the Canadian Westinghouse Co., Hamilton.

McGorman, S. E., '06, has Box 393 Walkerville, Ont., for his address.

McGowan, J., '95, is associate professor of applied mechanics at University of Toronto, Toronto, Ont.

McGregor, W. W., '05 (deceased).

McGregor, J. M., '08, has Ridgetown, Ont., for his home address.

McGugan, D. J., '07, is a member of the firm, Burnett & McGugan, civil engineers and land surveyors, New Westminster, B.C.

McIlwraith, D. G., '06, is chief draftsman for the Goldie & McCulloch Co., Limited, Galt, Ont.

McIntosh, A. H., '07, is with the Illinois Steel Co., Chicago, Ill.

McIntosh, W. G., '09, is with the Canada Foundry. His address is 125 Paton Rd., Toronto.

McKay, O., '85, has a practice as civil engineer and surveyor at Waterville, Ont.

McKay, C., '04 (deceased).

McKay, W. N., '95, is manager of the Bank of Hamilton at Georgetown Ont.

McKechnie, F. H., '09, has for his address 303 McKay St., Montreal, P.Q.

McKenzie, D. A., '11, is meter inspector with the Toronto Hydro Electric system.

McKenzie, D. W., '05, is draftsman in the engineering department of C. N. Railway, Winnipeg, Man.

McKenzie, J. A., '06, is a member of the firm of McKenzie, Broadfoot & Johnston, Vancouver, B.C.

McKim, L. R., '10, has Wyecombe, Ont., as his permanent address.

McKinnon, H. L., '95, is vice-president of the C. O. Bartlett & Snow Co., Cleveland, Ohio.

McLaren, A. J., '11—no record.

McLean, C. A., '05, is with the Canadian Westinghouse Co., Limited, at Toronto, Ont.

McLean, W. N., '05, has Erin, Ont., as his home address.

McLean, L. A., '08 (deceased).

McLeish, A. G., '11, is at Kananaskis Alta., operating the plant of the Calgary Power Co.

McLellan, R. A., '11—no record.

McLennan, A. L., '02, is in the office of the York County engineer.

McLeod, G., '09, is electrician for the Electric Light & Railway Co., Waupaca, Wis.

McMaster, A. T., C., '01, is engineer on design and construction for the Canadian Copper Co., Copper Cliff, Ont.

McMaster, W. A. A., '08, has Palmerston, Ont., as his address.

McMillan, J. G., '00, of 225 Geoffrey St., Toronto, is geologist for the T. & N. O. Railway.

McMillan, D., '04, is assistant engineer with the C. N. Railway at Edmonton, Alta.

McMillan, V., '09, is on engineering staff of the sewer department at the City Hall, Toronto.

McMordie, H. C., '08, is at Walkerville, Ont., with the Canadian Bridge Co.

McNab, J. V., '06, is resident engineer with C. P. Railway at Moose Jaw, Sask.

McNaughton, A. L., '03, is with the Grand Trunk Pacific Railway Co., at Prince Rupert, B.C.

McNaughton, F. W., '98, is deputy minister of public works, at Winnipeg, Man.

McNeill, F. W., '07, is with the Canadian General Electric Co., at Peterboro, Ont.

McNiven, J., '10, is on the designing staff of the Dominion Bridge Co., at Winnipeg, Man.

McPherson, A. J., '93, is city commissioner, Regina, Sask.

McPherson, J. A., '06, is a student in the faculty of medicine, University of Toronto.

McPherson, W. B., '11, is a student at law, Osgoode Hall, Toronto.

McQuarrie, M. K., '07, is resident engineer for the C. P. Railway, at Revelstoke, B.C.

McQueen, A. A., '11, is assistant manager of the Winnipeg Hydro Electric system, Winnipeg, Man.

McRoberts, A. A., '08.

McSloy, J. I., '10, has St. Catharines, Ont., for his address.

McTaggart, A. L., '94, is in the office of A. G. McKie, consulting engineer, Rockefeller Building, Cleveland, Ohio.

McVean, H. G., '01, has a practice as contractor and engineer at Regina, Sask.

WHAT OUR GRADUATES ARE DOING

D. H. Pinkey, '03, is mechanical engineer and chief draughtsman in the pipe mill department of the Lorain Works of the National Tube Co., Lorain, Ohio, U.S.A.

F. V. Seibert, B.A., Sc., D.L.S., '09, is with the Topographical Branch of the Department of Interior, at Edmonton, Alta.

J. M. Thompson, B.A., Sc., '13, is with the Dominion Bridge Co., at Lachine, P.Q.

J. H. Billings, B.A., Sc., '11, has accepted a position in the mechanical engineering department of the University of Missouri, Columbia, Mo., as instructor in Thermodynamics.

P. G. Welford, B.A., Sc., '11, is manager of the cost department of the Canada Machinery Corporation, Galt, Ont.

J. A. Elliott, B.A., Sc., '11, is now on the engineering staff of the Castner Electrolytic Alkali Co., Niagara Falls, N.Y.

K. E. Shaw, B.A., Sc., '13, is with the Canada Bridge Co., at Walkerville, Ont.

H. Harris, B.A., Sc., '13, is with the Detroit Edison Illuminating Co., at Detroit, Mich.

J. B. Goodwin, C.E., '92, is superintendent of the Midland Construction Co., at Healey Falls, Ont.

C. R. Holmes, B.A., Sc., '09, is sales engineer in Detroit for the Electric Storage Battery Co., of Philadelphia.

W. M. Brock, B.A., Sc., '11, is on the designing staff of the Canada Bridge Co., at Walkerville, Ont.

A. E. Holmes, B.A., Sc., '09, is sales engineer for the Canadian Westinghouse Co., at Montreal, P.Q.

James H. Craig, B.A., Sc. **H. Harrison Madill, B.A., Sc.**

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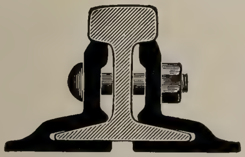

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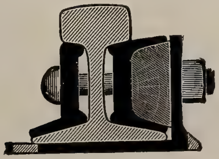

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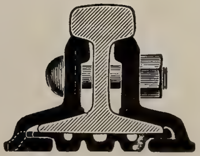

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